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भारतीय मानक

स्पंद जनित्रों की कार्यकारिता की अभिव्यक्ति

Indian Standard

EXPRESSION OF PERFORMANCE OF PULSE GENERATORS

ICS 29.160.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 7

Electronic Measuring Instruments, Systems and Accessories Sectional Committee, LTD 21

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Electronic Measuring Instruments, Systems and Accessories Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

The objective of this standard is to standardize the terminology for describing the functional performance, the performance characteristics and criteria for evaluating the performance of generators. It also standardizes the tests necessary to verify the performance of generators.

This standard is largely based on IEC Pub 624 (1978) 'Expression of the performance of pulse generators', issued by the International Electrotechnical Commission.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

EXPRESSION OF PERFORMANCE OF PULSE GENERATORS

1 SCOPE

1.1 This standard applies to the specification of pulse generators and to accessories used with generators.

1.2 Generators with continuous or pulsed sinusoidal outputs, television pattern generators, complex function generators, and generators for insulation resistance testing specially excluded from the scope of this standard.

2 REFERENCES

The Indian Standards given below are necessary adjuncts to this standard:

IS No.	*Title*
9176 : 1979	Method for specifying the functional performance of electronic measuring equipment
14501	Pulse techniques and apparatus:
(Part 1) : 1998	Pulse terms and definitions
(Part 2) : 1998	Pulse measurement and analysis, General considerations

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 Pulse Terms

The pulse terms used throughout this standard are defined in IS 14501 (Part 1).

3.2 Pulse Measurement and Analysis

Definitions of pulse measurement terms used and descriptions of pulse measurement techniques referred to in this standard are provided in IS 14501 (Part 2).

3.3 Pulse Generator Terms

3.3.1 *Pulse Generator*

An apparatus which supplies electrical energy in pulse form at an accessible output.

NOTE — Throughout this standard, the word 'generator' is used in place of 'pulse generator'.

3.3.2 *Generator Accessory*

A device or apparatus which is or may be a part of generator, associated with a generator, or associated with another generator accessory to modify or establish in a specified manner one or more characteristics of a generator.

NOTE — Throughout the remainder of this standard, the words 'generator accessory' is included in 'generator'.

3.3.2.1 *Permanent (non-permanent) generator accessory*

A generator accessory which is permanently (occasionally) associated with a generator and which is (is not) essential to its operation.

3.3.2.2 *Interchangeable generator accessory*

A non-permanent generator accessory which has its own properties which are independent of any generator with which it may be associated.

3.3.2.3 *Partially interchangeable generator accessory*

An interchangeable generator accessory which may be associated with a limited and specified set of generators or generator accessories.

3.3.2.4 *Non-interchangeable generator accessory*

A generator accessory which is associated with one particular generator. A non-interchangeable generator accessory and the generator with which it is associated have mutually interacting adjustments or characteristics. When such mutual interaction exists, this standard applies to the combination of the generator and the non-interchangeable generator accessory.

3.3.3 *Modular Generator*

A generator which is a combination of two or more generator accessories.

3.3.3.1 *Generator main frame*

A partially interchangeable generator accessory which provides common services and/or facilities (for example, mechanical mounting, a.c. and/or d.c. power, analogue and/or digital signal paths, cooling, etc) for itself and for one or more associated generator accessories. Typically, in the absence of other generator accessories, a generator main frame cannot function as a generator.

3.3.3.2 *Generator plug-in unit*

A partially interchangeable generator accessory which, typically:

a) may be associated with one or more specified generator main frames,

b) is adapted by plug and socket connections and its construction to use the services and/or facilities provided by the associated generator main frame, and
c) performs specified generator functions.

In the absence of a generator main frame, a generator plug-in unit cannot function as a generator.

3.4 Terms Related to the Performance of Generators

3.4.1 *Performance*

The degree to which the intended functions of a generator are accomplished.

3.4.2 *Performance Characteristic*

One of the quantities assigned to a generator in order to define by values, tolerances, ranges, etc, the performance of the generator.

NOTE — The term 'performance characteristic' does not include influence quantities (*see* Note under **3.4.3**).

3.4.3 *Influence Quantity*

Any quantity, generally external to a generator, which may affect the performance of the generator.

NOTE — Where a change of a performance characteristic affects another performance characteristic, it is referred to as an influencing characteristic (*see* **3.4.4** and **3.6.3**).

3.4.4 *Influencing Characteristic*

A performance characteristic which, when altered in value or state, produces a change in the value or state of one or more other performance characteristics (influenced characteristics).

3.4.5 *Terms Related to Values and Ranges*

3.4.5.1 *Rated value*

The value (or one of the values) of a quantity to be measured, observed, supplied or set, which the manufacturer has assigned to the apparatus.

3.4.5.2 *Rated range*

The range of a quantity to be measured, observed, supplied or set, which the manufacturer has assigned to the apparatus.

3.4.5.3 *Effective range*

That part of the rated range where measurements can be made or quantities be supplied within the stated limits of error.

3.4.6 *Terms Related to Error*

3.4.6.1 *Fiducial value*

A value to which reference is made in order to specify the relative error, for example, the upper limit of the effective range, or another clearly stated value.

3.4.6.2 *Absolute error*

The error expressed algebraically, in the unit of the measured or supplied quantity.

a) For measuring apparatus, the error is the indicated value of the measured quantity minus its true value, and
b) For a supply apparatus, the error is the true value of the quantity supplied minus its rated, indicated or pre-set value.

NOTE — The true value of a quantity is the value that would be measured by a measuring process having no error.

In practice, since this true value cannot be determined by measurement, a conventionally true value, approaching the true value as closely as necessary (having regard to the error to be determined), is used in place of the true value. This value may be traced to standards agreed upon by the manufacturer and the user, or to national standards. In both cases, the uncertainty of the conventionally true value shall be stated.

3.4.6.3 *Relative error*

The ratio of the absolute error to a stated value.

3.4.6.4 *Percentage error*

The relative error, expressed as a percentage, such as percent of full scale (the maximum value of the effective range), percent of the indicated or pre-set value or of the rated value.

3.4.7 *Terms Related to Stability*

3.4.7.1 *Stability*

The ability of the generator to maintain its indicated or supplied value during a specified time, other conditions remaining constant.

3.5 Terms Related to the Conditions of Testing, Operation, Transport and Storage

3.5.1 *Rated Range of Use*

The range of values for an influence quantity within which the requirements concerning operating error are satisfied.

3.5.2 *Rated Operating Conditions*

The whole of the effective ranges for performance characteristics, and rated ranges of use for influence quantities, within which the performance of the generator is specified.

3.5.3 *Reference Conditions*

A set of values with tolerances or a set of restricted ranges, fixed for influence quantities and for influencing characteristics if any, specified for making comparison and calibration tests.

3.5.4 *Limit Conditions of Operation*

The whole of the ranges of values for influence quantities and performance characteristics (beyond the rated ranges of use and effective ranges respectively) within which a generator can function without resulting in damage or degradation of performance when it is afterwards operated under rated operating conditions.

NOTE — The limit conditions will, in general, include overload.

3.5.5 *Conditions of Storage and Transport*

The whole of the conditions of temperature, humidity, air pressure, vibration, shock, etc, within which the generator may be stored or transported in an inoperative condition, without resulting in damage or degradation of performance when it is afterwards operated under rated operating conditions.

3.6 Limits of Error

The maximum values of error assigned by the manufacturer to a measured or supplied quantity of a generator operating under specified conditions.

3.6.1 *Operating Error*

The error determined under rated operating conditions.

3.6.2 *Intrinsic Error*

The error determined under reference conditions.

3.6.3 *Influence Error*

The error determined when one influence quantity assumes any value within its rated range of use (or an influencing characteristic assumes any value within its effective range) all others being at reference conditions.

NOTE — When over the whole rated range of use a substantially linear relationship exists between the influence error and the effect causing it, the relationship may be conveniently expressed in coefficient form.

3.6.4 *Stability Error*

The error which occurs in the indicated or supplied value of a generator during a specified time, other conditions remaining constant.

3.6.5 *Variation*

The difference between the values of a parameter when one influence quantity assumes successively two specified values within its nominal range of use, the others being at reference conditions.

NOTE — The 'nominal range of use' corresponds here to the 'rated range of use' appearing in this standard.

3.7 Technical Terms

3.7.1 *General Terms*

3.7.1.1 *Warm up time*

The time interval after switching on the generator under specified conditions, necessary for it to comply with all performance requirements.

3.7.1.2 *Preliminary adjustment*

A preliminary operation which, if required, precedes the operation of a generator and its associated generator accessories for measurement purposes, and in which specified adjustable parts are altered or set:

a) in accordance with the manufacturer's instructions;
b) without disassembly of the generator or its associated generator accessories; and
c) without the use of any additional apparatus, other than the associated generator accessories;

in order to provide operation of the generator which complies with all performance requirements.

3.7.2 *Generator Operating Modes and Controls*

A generator may operate in any of the operating modes defined in this clause where, except as noted, all defined operating modes are mutually exclusive.

3.7.2.1 *Normal mode (internal triggering mode)*

The operating mode in which a generator produces one output pulse for each cycle of an internally generated signal.

3.7.2.2 *Manual mode*

The operating mode in which a generator produces one output pulse for each actuation of a manual control.

3.7.2.3 *Triggered mode*

The operating mode in which a generator produces one output pulse for each occurrence or cycle of an electrical signal which is provided by other apparatus.

3.7.2.4 *Synchronized mode*

The operating mode in which a generator produces one output pulse for each cycle of an internally generated signal and in which the internal signal is synchronized with a signal which is provided by other apparatus.

3.7.2.5 *Burst mode*

The operating mode in which a generator produces a pulse burst with predetermined characteristic for each cycle of an internally generated signal and in which, for the pulse burst duration, operation may be in normal mode, triggered mode, or synchronized mode.

3.7.2.6 *Triggered burst mode*

The operating mode in which a generator produces a pulse burst with predetermined characteristics for each occurrence or cycle of an electrical signal which is provided by other apparatus and in which, for the pulse burst duration, operation may be in normal mode, triggered mode, or synchronized mode.

3.7.2.7 *Gated mode*

The operating mode in which a generator produces a pulse burst for the duration of an electrical signal which is provided by other apparatus and in which, for the pulse burst duration, operation may be in normal mode, triggered mode, or synchronized mode.

3.7.2.8 *Modulated mode*

The operating mode in which generator operation is identical to normal mode, triggered mode, or synchronized mode except that, in addition, the magnitude of a specified performance characteristic of the constituent pulses of the output pulse train is a function of the value of an electrical signal which may be provided by other apparatus.

3.7.2.9 *Square wave mode*

An operating mode of a generator which may be operative concurrently with any mode which is defined in **3.7.2.1** and **3.7.2.3** to **3.7.2.8** above, and in which the output pulses have a duty factor of 0.5.

3.7.2.10 *Double pulse mode*

An operating mode of a generator which may be operative concurrently with any other mode which is defined in **3.7.2.1** to **3.7.2.8** above, and in which the generator produces two output pulses for each cycle of an internally generated signal or each cycle or occurrence of an electrical signal from external apparatus. Typically, the two pulses thus produced have nominally identical characteristics, the second pulse being delayed in time relative to the first.

3.7.2.11 *Operating mode control*

A control which provides means for establishing the operation of a generator in one or more of the operating modes defined in **3.7.2.1** to **3.7.2.10** above.

3.7.3 *Input Signal Terms*

A generator, depending on the generator operating modes provided, may accept any of the input signals, and may have any of the input terminals or input signal controls defined in this clause.

NOTE — The input signal terms defined in this clause apply to inputs which are usually located on the front panel of a generator. Programming signals (*see* **5.1**), which are also input signals, usually have their inputs located on the rear panel of a generator. The distinction between the two types of inputs cannot be clearly drawn. If appropriate or desirable, any input may be described both in terms of this clause and as a programming signal input.

3.7.3.1 *Manual trigger*

A trigger which is actuated by hand in manual mode.

3.7.3.2 *Line trigger*

An electrical input signal, at the frequency of the line (mains) supply and normally derived internally, which may be operative in triggered mode.

3.7.3.3 *Trigger input*

An electrical input signal from external apparatus which may be operative in triggered mode.

3.7.3.4 *Synchronizing input*

An electrical input signal from external apparatus which is operative in synchronized mode.

3.7.3.5 *Burst trigger input*

An electrical input signal from external apparatus which is operative in triggered burst mode.

3.7.3.6 *Gate input*

An electrical input signal from external apparatus which is operative in gated mode.

3.7.3.7 *Modulating input*

An electrical input signal from external apparatus which is operative in modulated mode.

3.7.3.8 *Input terminal*

A multi-conductor electrical connection through which any of the electrical input signals defined in **3.7.3.3** to **3.7.3.7** or any other electrical input signal, may be introduced into a generator from other apparatus.

3.7.3.9 *Input terminal nomenclature*

The name of any generator input terminal is formed by appending the word 'terminal' after the name of the electrical input signal which the terminal will accept (for example, trigger input; trigger input terminal).

3.7.3.10 *Input value (amplitude) control*

A control which provides means for setting the internally effective value or amplitude of any of the electrical inputs to a generator.

3.7.3.11 *Input polarity (slope polarity) control*

A control which provides means for setting the internally effective polarity (slope polarity) of any of the electrical inputs to a generator.

3.7.4 *Input Circuit Terms*

The terms defined in this clause apply to all generator input circuits which accept the electrical input signals defined in **3.7.3.2** to **3.7.3.7**.

3.7.4.1 *Input impedance*

The impedance, expressed as:

a) complex impedance at a specified frequency,

b) equivalent resistance in parallel with an equivalent capacitance or inductance, or

c) equivalent resistance in series with an equivalent capacitance or inductance which is present at an input terminal.

3.7.4.2 *Input impedance nomenclature*

The name of any generator input impedance is formed by appending the word 'impedance' after the name of the electrical input signal (for example, trigger input; trigger input impedance).

3.7.4.3 *Input impedance control*

A control which provides means for setting the value of an input impedance of a generator.

3.7.5 *Output Signal Terms*

A generator, depending on the generator operating modes provided, may generate any of the output signals, and may have any of the output terminals or output signal controls defined in this clause.

NOTE — The output signal controls defined in this clause are, typically, manual controls which are located on the front panel of a generator. Programmable control of output signals (*see* **5.1**) may also be provided in a generator.

3.7.5.1 *Generator output*

The main or primary signal output(s) of a generator.

3.7.5.2 *Positive (negative) generator output*

A generator output which provides positive (negative) output pulses.

3.7.5.3 *Generator offset output*

An auxiliary electrical output signal which, when provided, is combined by superposition with the generator output.

3.7.5.4 *Trigger output*

An auxiliary electrical output signal which occurs coherently and in a predetermined time relationship with generator output pulses.

3.7.5.5 *End (beginning) of burst output*

An auxiliary electrical output signal which occurs once for each generator output pulse burst and in a predetermined time relationship to the end (beginning) of each pulse burst.

3.7.5.6 *Output terminal*

A multi-conductor electrical connection through which any of the outputs defined in **3.7.5.1** to **3.7.5.5** or any other signal output, may be taken from a generator.

3.7.5.7 *Output terminal nomenclature*

The name of any generator output terminal is formed by appending the word 'terminal' after the name of the electrical output which the terminal will deliver (for example, trigger output; trigger output terminal).

3.7.5.8 *Output value (amplitude) control*

A control which provides means for setting the value or amplitude of any of the electrical outputs from a generator.

3.7.5.9 *Output state (polarity) control*

A control which provides means for setting the state (polarity) of any of the electrical outputs from a generator.

3.7.6 *Output Circuit Terms*

The terms defined in this clause apply to all generator outputs which are defined in **3.7.5.1** to **3.7.5.5**.

3.7.6.1 *Output circuit*

An electrical circuit which is capable of delivering electrical energy through an associated output terminal to an impedance or apparatus external to the generator.

3.7.6.2 *Low impedance source*

An output circuit whose ideal equivalent circuit consists of an ideal voltage generator connected in series with an ideal resistance and which is designed to deliver electrical energy to an external resistive impedance which is large compared to the ideal series resistance.

3.7.6.3 *Specified impedance source*

An output circuit whose ideal equivalent circuit consists of an ideal voltage (current) generator connected in series (parallel) with an ideal resistance (conductance) and which is designed to deliver electrical energy to an external resistive impedance (conductive admittance) which is substantially equal to the ideal series resistance (parallel conductance).

3.7.6.4 *High impedance source*

An output circuit whose ideal equivalent circuit consists of an ideal current generator connected in parallel with an ideal conductance and which is designed to deliver electrical energy to an external conductive admittance which is large compared to the ideal parallel conductance.

3.7.6.5 *Source voltage*

The value of the voltage of the equivalent series voltage generator of a low impedance source or specified impedance source.

3.7.6.6 *Source current*

The value of the current of the equivalent parallel current generator of a high impedance source or specified impedance source.

3.7.6.7 *Source impedance*

The value of the equivalent complex series impedance of a low impedance source or specified impedance source.

3.7.6.8 *Source admittance*

The value of the equivalent complex parallel admittance of a high impedance source or specified impedance source.

3.7.6.9 *Source impedance (admittance) control*

A control which provides means for setting the value of the source impedance (admittance) of a source.

3.7.6.10 *Output impedance (admittance)*

The impedance (admittance) presented by the output terminal when the internal circuit is a load for, rather than a source of, electrical energy.

NOTE — In many cases, this is identical with the source impedance.

3.7.6.11 *Rated values and ranges of load impedance (admittance)*

a) In the case of a low impedance source; the rated value of the minimum load impedance,
b) In the case of a specified impedance source; the rated range of use of the load impedance (admittance), and
c) In the case of a high impedance source; the rated value of the minimum load admittance,

for which the generator will comply with all performance requirements.

3.7.7 *Input-Output Terms*

3.7.7.1 *Output delay*

The pulse delay interval between a trigger input signal and its associated generator output pulse.

3.7.7.2 *Trigger output advance (delay)*

The pulse advance (delay) interval between a generator output pulse and its associated trigger output signal.

3.7.7.3 *Other input-output advance (delay) terms*

Signal advance and/or delay may exist between any pair of the following signals:

- manual trigger,
- line trigger,
- trigger input,
- synchronizing input,
- burst trigger input,
- gate input,
- modulating input,
- generator output,
- positive (negative) generator output,
- trigger output, and
- end (beginning) of burst output.

The name of the advance (delay) between any pair of the signals listed above, except those defined in **3.7.7.1** and **3.7.7.2**, is formed by the sequence 'name of first signal' to 'name of second signal' advance (delay) (for example, trigger input to trigger output delay).

3.7.8 *Indicator Terms*

3.7.8.1 *Indicator*

A device which is capable of producing a visually or aurally perceptible signal or indication.

3.7.8.2 *Fault indicator*

An indicator which is automatically actuated or energized when the operation of a generator is, unless otherwise specified, not within the range of rated operating conditions. A fault indicator may be associated with a fault protection circuit (*see* **3.7.9.1**).

3.7.8.3 *Overload indicator*

A fault indicator which is automatically actuated or energized when the output voltage, current, or power, as specified, of a generator exceeds its rated value.

3.7.8.4 *Short-circuit indicator*

A fault indicator which is automatically actuated or energized when the load impedance which is connected to a generator output is less than the rated load impedance.

3.7.8.5 *Open-circuit indicator*

A fault indicator which is automatically actuated or energized when the load admittance which is connected to a generator output is less than the rated load admittance.

3.7.8.6 *Duty factor limit indicator*

A fault indicator which is automatically actuated or energized when the duty factor of a generator output is greater than the maximum rated duty factor.

3.7.8.7 *Output meter*

An integral calibrated indicator which indicates the value of a specified generator output.

3.7.9 *Fault Protection Terms*

3.7.9.1 *Fault protection circuit*

A circuit associated with a generator output circuit which automatically operates to protect the generator circuitry from damage when operation is not within the range of rated operating conditions. A fault protection circuit may be associated with a fault indicator.

3.7.9.2 *Fault reset*

A manual input which may be associated with and, when provided, must be actuated after a fault protection circuit has operated and after the conditions which caused the fault protection circuit to operate have been corrected in order to restore a generator to normal operation.

3.7.9.3 *Overload protection circuit*

A fault protection circuit which operates automatically when the power output of a generator output exceeds its rated value.

3.7.9.4 *Short-circuit protection circuit*

A fault protection circuit which operates automatically when the load impedance which is connected to a generator output is less than the rated load impedance.

3.7.9.5 *Open-circuit protection circuit*

A fault protection circuit which operates automatically when the load admittance which is connected to a generator output is less than the rated load admittance.

3.7.9.6 *Duty factor limit protection circuit*

A fault protection circuit which operates automatically when the duty factor of a generator output is greater than the rated duty factor.

4 CATEGORIES OF PERFORMANCE CHARACTERISTICS

4.0 This clause lists categories of performance characteristics, on the basis of units of measurement. The lists provided in the following clause are not exhaustive; they are representative.

NOTE — Throughout the remainder of this standard, except where otherwise specified, all clauses are written in terms of categories of performance characteristics.

4.1 Frequency Category

Quantities of which the unit of measurement is the hertz, for example:

- pulse repetition frequency,
- pulse burst repetition frequency,
- modulating input frequency,
- synchronizing input frequency,
- trigger input frequency, and
- burst trigger input frequency.

4.2 Temporal Category

Quantities of which the unit of measurement is the second, minute, hour, etc.

4.2.1 *Interval Category*

Temporal quantities for which time is measured as the difference between two specified instants, for example:

- output delay,
- trigger output advance (delay),
- advance and/or delay between any pair of the following:
    - manual trigger,
    - line trigger,
    - trigger input,
    - synchronizing input,
    - burst trigger input,
    - gate input,
    - modulating input,
    - generator output,
    - positive (negative) generator output,
    - trigger output,
    - end (beginning) of burst output, and
    - jitter of any of the above.

4.2.2 *Duration Category*

Temporal quantities for which time is measured as the duration between two specified instants, for example:

- trigger input pulse duration,
- trigger input first transition duration,
- synchronizing input pulse duration,
- synchronizing input first transition duration,
- burst trigger input pulse duration,
- burst trigger input first transition duration,
- gate input pulse duration,
- gate input first transition duration,
- output pulse duration,
- output pulse first transition duration,
- output pulse last transition duration,
- positive (negative) output pulse duration,
- positive (negative) output pulse first transition duration,
- positive (negative) output pulse last transition duration,
- trigger output pulse duration,
- trigger output first transition duration,
- end (beginning) of burst output pulse duration,
- end (beginning) of burst output pulse first transition,
- duration, and
- jitter of any of the above.

4.3 Voltage (Current) Category

Quantities of which the unit of measurement is the volt (ampere), for example:

- trigger input pulse amplitude,
- synchronizing input pulse amplitude,
- burst trigger input pulse amplitude,
- gate input pulse amplitude,
- modulating input signal value,
- output pulse amplitude,
- output pulse offset,
- positive (negative) output pulse amplitude,
- positive (negative) output pulse offset,
- trigger output pulse amplitude,
- end (beginning) of burst output pulse amplitude,
- fluctuation of any of the above,
- pulse waveform distortion, and
- pulse waveform feature distortion.

4.4 Power Category

Quantities of which the unit of measurement is the watt or the volt-ampere, for example:

- input supply power,
- input supply volt-amperes, and
- output pulse power.

4.5 Impedance (Admittance) Category

4.6 State Category

Quantities which are described by the assignment of two or more descriptions of states.

4.6.1 *Polarity Category*

State quantities of which the states are positive (+) and negative (–), for example:

- trigger input pulse polarity,
- trigger input slope polarity,
- synchronizing input pulse polarity,
- burst trigger input pulse polarity,
- modulating input signal polarity,
- trigger output pulse polarity,
- end (beginning) of burst output pulse polarity,
- generator output pulse polarity, and
- generator output offset polarity.

4.6.2 *Assigned State Category*

State quantities of which the states are 'on' and 'off' or two or more other specified states, for example:

- operating mode, that is:
- normal mode,
- manual mode,
- triggered mode,
- synchronized mode,
- burst mode,
- triggered burst mode,
- gated mode,
- modulated mode, and
- square wave mode;
- double pulse mode.

4.7 Dimensionless Category

Quantities which are expressed as a ratio or as a percentage, for example:

- symmetry,
- duty factor,
- voltage standing wave ratio,
- reflection coefficient,
- percent pulse waveform distortion, and
- percent pulse waveform feature distortion.

5 TYPES OF CONTROL OF PERFORMANCE CHARACTERISTICS

5.0 This clause describes the types of control, or absence of control, of any performance characteristic which may be provided in a generator. Throughout the remainder of this standard, except where otherwise specified, all clauses are written in terms of types of control provided for quantities.

5.1 Control in General

5.1.1 *Provision of Control*

Any quantity of a generator may have associated:

a) manual control means [for example, knob(s), switch(es), lever(s), push-button(s), etc, or combinations thereof]; and/or

b) programme control means (for example, digital signal inputs or analogue signal inputs, or combinations thereof),

with which the value, amplitude, occurrence, or state of quantity which is to be supplied or set may be established.

5.1.2 *Quantity Manual Control Nomenclature*

When manual control of a quantity is provided, the name of the control is formed by appending the word 'control' after the name of the quantity (for example, pulse duration; pulse duration control). When more than one manual control is provided, such controls are distinguished by the use of additional descriptive words (for example, 'coarse', 'fint', 'range', 'vernier', etc.)

NOTE — The inclusion of the appended 'control'on the front panel or other markings on a generator is optional.

5.1.3 *Quantity Programme Control Nomenclature*

When programme control of a quantity is provided, the name of the programme input is formed by appending the words 'programme control' after the name of the quantity (for example, pulse duration; pulse duration programme control). When more than one programme control input is provided, such inputs are distinguished by the assignment of designations to connector pins or terminals.

NOTE — The inclusion of the appended words 'programme control' in the marking on a generator is optional.

5.2 Specific Types of Control

This clause describes the types of control of quantities which may be provided by manual and/or programme means. In principle, any of these types of control may be associated with any quantity in any of the categories of quantities defined in **4**.

5.2.1 *Fixed Quantity*

A quantity for which no control is provided.

5.2.1.1 *Calibrated fixed quantity*

A fixed quantity whose value is specified.

5.2.1.2 *Uncalibrated fixed quantity*

A fixed quantity whose value is partially specified, that is, for which limits of error are not stated.

5.2.2 *Switched Quantity*

A quantity whose control provides two or more distinct values, amplitudes, or states.

5.2.2.1 *Calibrated switched quantity*

A switched quantity whose distinct values or amplitudes are specified.

5.2.2.2 *Uncalibrated switched quantity*

A switched quantity whose distinct values or amplitudes are partially specified, that is, for which limits of error are not stated.

5.2.2.3 *Switched quantity with assigned states*

A switched quantity whose distinct states are assigned (for example, on, off, positive, negative, etc).

5.2.3 *Adjustable Quantity*

A quantity whose control provides a monotonic continuum of values as a function of actuation of the control in one direction or sense over its complete range.

5.2.3.1 *Calibrated adjustable quantity*

An adjustable quantity whose control has a multiplicity of nominally resettable positions wherein each nominally resettable position is associated with a specified value.

5.2.3.2 *Uncalibrated adjustable quantity*

An adjustable quantity whose control provides partially specified values, that is, for which limits of error are not stated.

5.2.3.3 *Conditionally calibrated adjustable quantity*

An adjustable quantity or a calibrated adjustable quantity whose control has one or more distinct resettable positions wherein each distinct resettable position is associated with a specified value.

5.3 Multiple-Controlled Quantity

A quantity for which two or more controls are provided wherein any or all of the controls may be any of the controls defined in **5.2** above.

5.4 Dual-Controlled Quantity

A quantity for which both manual control means and programme control means are provided wherein any or all of the controls may be any of the controls defined in **5.2** and **5.3**, above.

6 STATEMENT OF PERFORMANCE

6.1 Values and Limits of Error

The quality and nature of the functional performance of a generator is defined by statements of:

a) the limits of error of the values of certain performance characteristics,

b) the maximum, minimum, or nominal values of certain performance characteristics; and

c) the states provided for certain performance characteristics,

wherein the statement applicable to a particular quantity is determined by the specific type of control which is provided for that quantity.

6.2 Required Statements (Described in this Standard)

Statements of the limits of operating error or statements of values shall be made in accordance with clauses listed in Table 1, col 3 and 4, for all performance characteristics of a generator. Statements on influence quantities shall be made in accordance with **6.8**.

6.3 Optional Statements (Described in this Standard)

Statements of the (a) limits of intrinsic error, (b) limits of influence error, (c) limits of stability error and (d) variation of any or all quantities of a generator whose specification complies with this standard if made, shall be in accordance with clauses listed in Table 1, col 5, 6, 7 and 8, respectively.

6.4 Optional Statements (Not Described in this Standard)

Statements of limits of error or statements of values mutually agreed upon by the manufacturer and the user but not described in this standard may be made.

6.5 Specification of Characteristic Quantities

All statements of limits of error or values required by **6.5.1** to **6.5.8** below, which may apply to any quantity listed in the categories of performance characteristics shall be in the unit of measurement which is specified for the particular quantity. Statements on influence quantities shall be made in accordance with **6.8**.

6.5.1 *Specification of a Calibrated Fixed Quantity*

The manufacturer shall specify the limits of error of the quantity.

6.5.2 *Specification of an Uncalibrated Fixed Quantity*

The manufacturer shall specify the minimum or maximum and/or nominal value of the quantity.

6.5.3 *Specification of a Calibrated Switched Quantity*

The manufacturer shall specify the limits of error of the quantity for each switched position.

6.5.4 *Specification of an Uncalibrated Switched Quantity*

The manufacturer shall specify the minimum or maximum and/or nominal value of the quantity for each switched position.

Table 1 Types of Control Related to Statements of Performance

(*Clauses* 6.2 *and* 6.3)

Type of Control		Type of Error					
	Defined in	Value (*See* Note 1)	Operating Error (*See* Note 1)	Intrinsic Error (*See* Note 2)	Influence Error (*See* Note 2)	Stability Error (*See* Notes 2 and 3)	Variation (*See* Note 2)
1	2	3	4	5	6	7	8
Calibrated fixed	5.2.2.1	—	6.5.1		6.5.1	6.5.1	6.5.1
Uncalibrated fixed	5.2.1.2	6.5.2	—		—	—	—
Calibrated switched	5.2.2.1	—	6.5.3		6.5.3	6.5.3	6.5.3
Uncalibrated switched	5.2.2.2	6.5.4	—		—	—	—
Assigned switched	5.2.2.3	6.5.5	—		—	—	—
Calibrated adjustable	5.2.3.1	—	6.5.6		6.5.6	6.5.6	6.5.6
Uncalibrated adjustable	5.2.3.2	6.5.7	—		—	—	—
Conditionally calibrated	5.2.3.3	6.5.8	6.5.8		6.5.8	6.5.8	6.5.8
Multiple-controlled	5.3	6.6	6.6		6.6	6.6	6.6
Dual-controlled	5.4	6.7	6.7		6.7	6.7	6.7
General test conditions	7	7	7		7	7	7
Specific test conditions	8	—	8.1 and 8.2		8.3	8.4	8.5

NOTES

1 Required for all performance characteristics. *See* specified clauses for method of statement.

2 Optional for all performance characteristics. Specified references apply to those performance characteristics for which limits of intrinsic error, influence error, or stability error limits or variation are specified.

3 When the stability error is not included in the operating error, separate statements of the limits of stability error are required.

6.5.5 *Specification of a Switched Quantity with Assigned States*

The manufacturer shall provide a numerical and/or word description of the range or state of the quantity for each switched position.

6.5.6 *Specification of a Calibrated Adjustable Quantity*

The manufacturer shall specify the limits of error of the quantity which are applicable within the entire effective range of the quantity.

6.5.7 *Specification of an Uncalibrated Adjustable Quantity*

The manufacturer shall specify the minimum and maximum values of the rated range of the quantity.

6.5.8 *Specification of a Conditionally Calibrated Adjustable Quantity*

The manufacturer shall specify the limits of error of the quantity at each of the distinct resettable positions provided and shall specify the minimum and maximum values of the rated range of the quantity.

6.6 Specification of Multiple-Controlled Quantities

The manufacturer shall specify the limits of error or values, as applicable, of the quantity in all combinations of all types of controls which are associated with the multiple-controlled quantity where for each control the applicable **6.5.3** to **6.5.8** shall apply.

6.7 Specification of Dual-Controlled Quantities

Any quantity of a generator may have both manual control means and programme control means. When both means of control are provided, the manufacturer shall specify the following.

6.7.1 *Control Section*

The means or techniques by which the manual control means (programme control means) are activated to permit control of the quantity while the programme control means (manual control means) are deactivated.

6.7.2 *Provision of Override*

The means or techniques by which and the conditions under which the manual control means (programme control means) may or will override the programme control means (manual control means).

6.7.3 *Dual Specification of a Quantity*

When both manual control means and programme control means are associated with a quantity, the type of control provided (as defined in **5.2** and **5.3**) may differ in the two cases. when the two types of control differ, the quantity shall be specified twice, firstly for manual control and secondly for programme control.

6.8 Form of the Specification of Influence Error

The limits of influence error of a specified quantity of a generator shall be specified by the manufacturer in accordance with **6.8.1** or **6.8.2**, below.

6.8.1 *Specification of Limits of Influence Error*

The limits of influence error over the effective range of quantity may be specified.

NOTE — This form of specification is convenient when no substantially linear relationship exists between the influence error and the influence quantity of influencing characteristic causing the error.

6.8.2 *Specification in Coefficient Form*

The influence error over the effective range of a quantity may be specified in coefficient form including the appropriate sign, so that a correction formula can be applied.

NOTE — This form of specification is appropriate when a substantially linear relationship exists between the influence error and the influence quantity or influencing characteristic causing the error. Although, this form of specification does not specify limits of influence error, typically, the influence error is significantly less than the intrinsic error, and the absence of limits of influence error is not important.

6.8.3 *Usage Groups*

The reference values or ranges,the rated ranges of use and the limit ranges of operation, storage and transport, for all influence quantities shall be selected from only one of the usage Groups I, II or III in **6** of IS 9176.

These usage groups are:

Usage Group I: For indoor use and under conditions which are normally found in laboratories and factories and where generators will be handled carefully.

Usage Group II: For use in environments having protection from full extremes of environment and under conditions of handling between those of Groups I and III.

Usage Group III: For outdoor use and in areas where the generator may be subjected to rough handling.

Any exceptions to the values given in **7** shall be explicitly and clearly stated by the manufacturer with an indication that they are exceptions.

The generator may correspond to one group of rated ranges of use for environmental conditions and to another group for mains supply conditions, but this shall be clearly stated by the manufacturer.

7 GENERAL CONDITIONS FOR TESTING

7.1 Test Equipment

7.1.1 In general, measurements for verification shall be carried out with instruments which will not appreciably (or only calculably) affect the values to be measured. In principle, the errors in measurements made with these instruments should be negligible in comparison with the errors to be determined.

7.1.2 When the error of the instrument is not negligible, the following rule shall apply.

If a generator is claimed to have a limit of error of $\pm e$ percent for a given performance characteristic and the manufacturer uses for its checking an apparatus resulting in an error of measurement of $\pm n$ percent, the error being checked shall remain between the limits $\pm(e-n)$ percent. Likewise, if a user checks the same generator using another apparatus resulting in an error of measurement of $\pm m$ percent, he is not entitled to reject the generator if its apparent error exceeds the limits of $\pm e$ percent, but remains within the limits of $\pm(e+m)$ percent.

7.2 Period for Achievement of Stable Operation

The supply voltage shall be applied for a period equal to the warm up time as specified by the manufacturer or, in the absence of such information, for a period of 1 h.

7.3 Performance of Preliminary Adjustments

Any preliminary adjustments specified by the manufacturer shall be carried out before beginning the measurements.

7.4 Connected Load

The rated ranges of load impedance (admittance) shall be connected to a generator through out all tests except for specified tests which require other load impedances (admittances).

7.5 Output Value

The voltage (current) output of a generator output shall be set at the maximum rated output value throughout all tests except for specified tests which require other values.

7.6 Control of Influence Quantities

Throughout all tests all influence quantities shall remain within the limits specified for the applicable usage group (*see* **6.8.3**).

7.7 Testing

The tests shall be divided into three categories and the sampling rates for type tests and batch tests shall be agreed between the interested parties. This standard does not specify which category of test is applicable to the various performance characteristics. The applicable categories should be specified by agreement between manufacturer and user. All tests stated are type tests unless agreed otherwise by the manufacturer and the user. The three categories of tests are:

a) Type tests, which are made on a single generator of each design or on a small number of generators of the same design.

b) Batch tests, which are made only on a fraction of a production or delivery batch.

c) Routine tests, which are made on all generators of a production or delivery batch.

8 SPECIFIC CONDITIONS FOR TESTING

8.1 Test Conditions Applicable to Operating Error

The limits of operating error of a quantity of a generator specified by the manufacturer shall be valid under rated operating conditions.

8.2 Test Conditions Applicable to Intrinsic Error

The limits of intrinsic error of a quantity of a generator shall be valid under the reference conditions specified by the manufacturer.

The specified reference conditions should, preferably, be in accordance with IS 9176 : 1979.

8.3 Test Conditions Applicable to Influence Error

8.3.1 *Influence Error Due to an Influencing Characteristic*

Throughout the determination of the influence error of a specified quantity caused by changes in the value of a specified influencing characteristic:

a) the value of the specified influencing characteristic shall be changed within its effective range,

b) all influence quantities shall be maintained at any constant value within the reference conditions, and

c) unless otherwise specified by the manufacturer, all other influencing characteristics shall be maintained at any constant value within the reference conditions.

8.3.2 *Influence Error Due to an Influence Quantity*

Throughout the determination of the influence error of a specified quantity caused by changes in the value of a specified influence quantity the values of all other influence quantities and influencing characteristics shall be maintained within reference conditions.

8.3.3 *Influence Error Due to Temperature*

Measurements for the determination of influence error shall be performed after a time interval following the change in temperature in order that thermal equilibrium may be established. This elapsed time interval:

a) may be specified by the manufacturer, and
b) shall not be greater than 1 h.

8.3.3.1 *Limits of influence error due to temperature*

The limits of influence error for the rated range of use shall be specified in accordance with **6.8.1**.

NOTE — Typically, and unless otherwise specified by the manufacturer, measurement at intervals of 10 °C throughout the rated range of use are adequate for the determination of the limits of influence error.

8.3.3.2 *Coefficient of influence error due to temperature*

The coefficient of influence error for the rated range of use shall be specified as the change per 1°C and in accordance with **6.8.2**.

NOTE — Typically, and unless otherwise specified by the manufacturer, two measurements at temperatures differing by 10°C within the rated range of use are adequate for the determination of the coefficient of influence error.

8.3.4 *Influence Error Due to Supply Voltage*

Measurements for the determination of the limits of influence error shall be performed when the mains supply voltage is abruptly changed from its rated value to:

a) 110% of its rated value, and
b) 90% of its rated value.

In each case, changes in the value of the quantity relative to its value before the change in the value of the mains supply voltage shall be specified as follows:

a) the maximum positive and negative changes during the first minute, and
b) the change after a time interval of 15 min.

8.4 Test Conditions Applicable to Variation

The limits of variation of a specified quantity shall be determined as the change in value of the quantity when the specified influence quantity is changed from its reference value (or the limit of its reference range) to any specified value within its rated range of use. Throughout the determination of the limits of variation all other influence quantities and influencing characteristics shall be maintained within reference conditions.

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